HOW TO CUT THE ALBEDO-ELECTRONS

Taro Kotani, Robert Hartman, Steve Ritz, & Tune Kamae

010831

`itehu:~kotani/glast.itehu/txt/010831.kotani2.albedoparticles1`
`http://lheawww.gsfc.nasa.gov/users/kotani/glast/010831.kotan2.albedoparticles1.ps`
`http://lheawww.gsfc.nasa.gov/users/kotani/glast/010831.kotan2.albedoparticles1.pdf`

As reported in Kotani & Kamae (2001/07/30) and Riport 18, the BGD-event rate in orbit due to albedo electrons can be up to 0.15 Hz, a horrible number. (According to Mizuno, the rate is underestimated by a factor of $2 \sim 3$.) To reduce the rate, development of a special filter to cut albedo particles and/or extending the height of the ACD wall by ~ 10 cm are considered necessary. The former solution is far cheaper and the latter is more reliable. Here we report how effective each approach is. Should we have a tall ACD? It depends on the cost.

1 A New Filter to Cut Albedo Electrons

Filter logic to cut albedo electrons are coded in ROOT and tested. The logic implemented is shown in Table 1. An event satisfying all the conditions is kept as a photon candidate. The threshold, set to 100 MeV here, need a careful calibration in future. It should be noted that the filter is under development and the definition is not at all final.

Bellow are filter logic not yet implemented. If all in Table 1 fail, try these.

- Cal_Energy_Deposit > 100 MeV || The intersection of the best track on top of the CAL is within the central 4 towers.
  Low-energy events in the outer towers are cut.
- Cal_Energy_Deposit > 100 MeV || The intersection of the pair track on top of the CAL is within the central 4 towers.
  Low-energy events in the outer towers are cut.

Table 1: Albedo-particle filter
These definitions/codes are under development and subject to change.

Name	Code/Definition
Albedo_e 0	Cal_Energy_Deposit > 100 || ACD_TileCount = 0
	Low-energy events with any ACD hits are cut.
Albedo_e 1	TKR_Fit_Type $\geq$ 22
	Is incident γ reconstructed?
Albedo_e 2	projection of best track hits CAL && projection of pair track hits CAL
Albedo_e 3	Cal_Energy_Deposit > 100 || TKR_First_XHit< 11 || TKR_First_XHit> 14
	Low-energy events converted in the thick layers are cut.
Albedo_e 4	(best track vector $\cdot$ pair track vector)> 0.5
	Angle between the pair $< 60°$.
Albedo_e 5	Cal_Energy_Deposit > 100 ||(|TKR_Pair_x0| < 37.3 && |TKR_Pair_y0| < 37.3)
	Is the initial vertex within the central four towers?

Table 2: Parameters of the simulation

Tag	Albedo e	Albedo p	Heavenly γ
Code	pdrApp v5r1	pdrApp v5r1	pdrApp v5r1
ACD Height	76.75 cm	76.75 cm	86.75 cm
Source Area	6 m^{-2}	6 m^{-2}	6 m^{-2}
Spectrum	100 MeV	100 MeV	E^{-1} (17.78 MeV $< E <$ 17.78 GeV)
Angle	$-0.7 < \cos\theta < 0.7$	$-0.7 < \cos\theta < 0.7$	$0 < \cos\theta < 1$
Generated	5×10^5	5×10^5	10^5

- There must not be any TKR hits above the Λ shape.
  Photon events are not considered to make a signal above the Λ.

The new filter is applied to events simulated with `pdrApp`. The parameters of the simulations are shown in Table 2. The performance of the filter is shown in Table 3. Wow! A ratio of remaining albedo-electron events of $\sim 10^{-5}$ is achieved! But it should be stressed that this result is too optimistic. Since the energy of the incident electrons is set to 100 MeV, the threshold value of 100 MeV adopted in the albedo filter is quite effective. The filter would not be so effective to the source with a more realistic spectrum, and a careful calibration of the threshold energy will be required. It should be also noted that the albedo-particle filter cuts a half the photon events. The real photons with a steeper spectrum would be lost more. The albedo filter may be too harsh and need to be loosened. Anyway, it can be said that the albedo filter reduces the remaining albedo particles by at least a factor of ~ 10. Even if the albedo particle flux is as strong as 30 $\mathrm{m}^{-2}\ \mathrm{s}^{-1}\ \mathrm{str}^{-1}$ (Mizuno 2001), the final rate would be < 0.01 Hz.

This study must be carefully compared with the results with the AO code. Firstly, the effective area seems to be shrunken by 20 %. A simulation with the AO code with the same parameters as in the last column of Table 2 shows an acceptance ratio of 3.4 % to the generated photons, while the corresponding value in Table 3 is $2669/10^5 = 2.6$ %. (The number of events surviving the AO filter in Table 2 in Riport 21 has an error and is corrected in Table 3.) This may be due to the small column density of lead in the new geometry, or due to inappropriate treatment of changed NTuples.

2 The Taller ACD

To study the effect of the height of the ACD, albedo-electron events are simulated under several ACD configurations. The parameters of the simulation are same as those in Table 2 except for the ACD height. The AO filter set and the prototype of the albedo-particle are applied. The remaining ratio is plotted in Fig. 1.

It is puzzling that the taller-by-10-cm ACD cuts only half of the remaining events, while the ratio of BGD events will be improved by a factor of 10 if the height is extended by 20 cm. It is necessary to investigate the remaining events one by one.

Anyway, the resultant BGD-event rate due to albedo electrons would be 10^{-3} Hz.

References

[1] Kotani, 2001/07/25, Riport 18,
http://lheawww.gsfc.nasa.gov/users/kotani/glast/010725.kotani2.riport18.ps

[2] Kotani & Kamae, 2001/07/30,
http://lheawww.gsfc.nasa.gov/users/kotani/glast/010730.kotan2.albedoparticles.ps

[3] Mizuno et al. 2001, Cosmic Ray Generator for GLAST Geant4 Simulation
http://www.slac.stanford.edu/~mizuno/GLAST/Geant4/CRGene_2001-06-30.pdf
http://www.slac.stanford.edu/~mizuno/GLAST/Geant4/Appendix_2001-07-09.pdf

Table 3: Performance of the albedo-particle filter

The "each" column shows the effect of each filter if applied solely. The "accumulative" column shows the accumulative effect of all the filters. The "all but" column shows the effect of all the other filters without it. All ratios are to the number of L1-triggering events, except that the ratio of the L1T row is to the number of generated events.

Albedo e

filter	each		accumulative		all but	
	#	Ratio	#	Ratio	#	Ratio
L1T	88296	0.476069	88296	0.476069	2	1.07835e-05
AO filter	84924	0.96181	792	0.00427026	2	1.07835e-05
Albedo_e 0	4804	0.0544079	392	0.00211356	19	0.000102443
Albedo_e 1	12108	0.13713	66	0.000355855	28	0.000150969
Albedo_e 2	37729	0.427301	21	0.000113226	3	1.61752e-05
Albedo_e 3	77861	0.881818	14	7.54843e-05	3	1.61752e-05
Albedo_e 4	87885	0.995345	11	5.93091e-05	2	1.07835e-05
Albedo_e 5	24704	0.279786	2	1.07835e-05	11	5.93091e-05

Albedo p

filter	each		accumulative		all but	
	#	Ratio	#	Ratio	#	Ratio
L1T	56128	0.305518	56128	0.305518	0	0
AO filter	51861	0.923977	550	0.00299378	0	0
Albedo_e 0	13437	0.239399	533	0.00290125	0	0
Albedo_e 1	169	0.00301097	2	1.08865e-05	1	5.44324e-06
Albedo_e 2	29974	0.534029	0	0	0	0
Albedo_e 3	51082	0.910098	0	0	0	0
Albedo_e 4	56118	0.999822	0	0	0	0
Albedo_e 5	20910	0.372541	0	0	0	0

Heavenly γ

filter	each		accumulative		all but	
	#	Ratio	#	Ratio	#	Ratio
L1T	22271	0.815758	22271	0.815758	1134	0.0415369
AO filter	20780	0.933052	2669	0.097762	1259	0.0461155
Albedo_e 0	16809	0.754748	2628	0.0962602	1136	0.0416102
Albedo_e 1	9058	0.406717	1683	0.0616461	1618	0.0592652
Albedo_e 2	15653	0.702842	1486	0.0544302	1196	0.0438079
Albedo_e 3	20352	0.913834	1368	0.0501081	1165	0.0426724
Albedo_e 4	22162	0.995106	1365	0.0499982	1133	0.0415003
Albedo_e 5	16019	0.719276	1134	0.0415369	1363	0.0499249

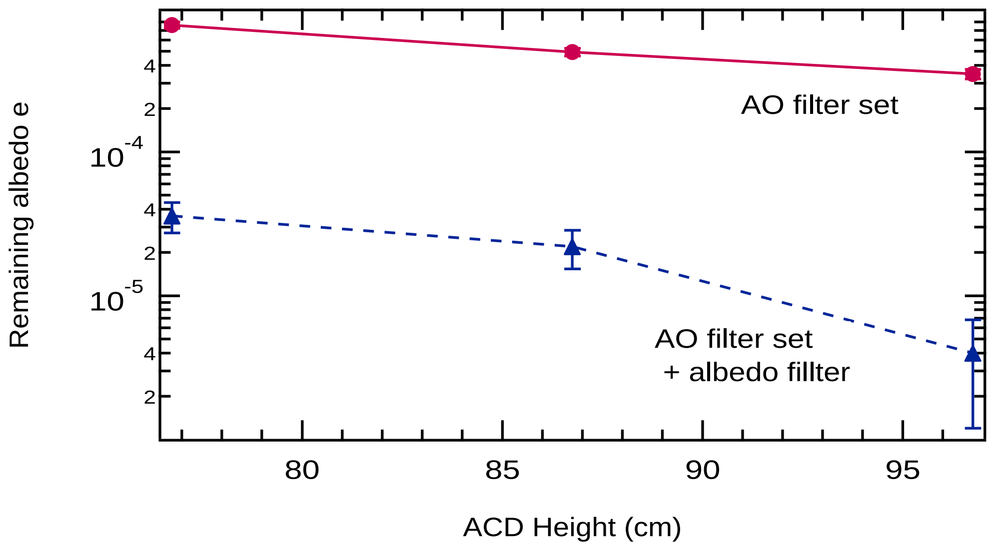

Figure 1: Remaining Albedo e vs. ACD height
The ratio of remaining albedo electrons to generated ones is plotted as function of the height of the ACD. The nominal height is 76.75 cm.